

Example 5 - Greenhouse Gas PSD Applicability Example Determination Calculations

Natural Gas Compressor Stations

Completed by: Mark Peterson, Air Resources Management Bureau

Example Scenario 5: Add one engine to existing non-listed major source natural gas compressor station facility. For this hypothetical example, let's assume that the existing facility potential to emit (PTE) for carbon dioxide equivalent (CO₂e) is greater than 100,000 tons/yr and the PTE for greenhouse gas (GHGs) emissions is greater than 100 tons/yr.

STEP #1 – Identify Emitting Unit Added to the facility

- Add one (1) 800 Brake Horsepower (bhp) Compressor Engine

STEP #2 – Calculate Potential Increase in Emissions from Engine

For this example, let's assume increase in emissions for each of the following criteria pollutants are as follows:

PM₁₀ = 0.26 tons per year (tpy)

CO = 13.90 tpy

NO_x = 115.87 tpy

SO_x = 0.02 tpy

VOC = 1.54 tpy

STEP #3 – Determine PSD Applicability for Criteria Pollutants

Based on the hypothetical PTE calculations above, the proposed modification increased NO_x emissions above significant levels.

STEP #4 – Determine PSD Applicability for GHGs and Calculate PTE for GHGs

In this step we will need to calculate the potential emissions for the applicable GHGs. GHGs listed in the final rule include carbon dioxide (CO₂), methane (CH₄), nitrous oxide (N₂O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF₆). (Note: Some of these GHGs have a higher global warming potential (GWP) than the others so they are expressed in CO₂ equivalents (CO₂e) in order to help standardize the evaluation of GHGs and determine if a facility is covered by a permitting program.)

For this hypothetical example, however, we will focus on the stationary combustion sources (e.g., as the natural gas compressor engines and reboilers) in which CO₂, CH₄, and N₂O are the GHGs that are formed during the combustion process.

In general, there two basic approaches that may be used to estimate greenhouse gases from a combustion source.

- 1.) Direct measurement (e.g., CEMS).

- 2.) Calculation based method.
 - a.) Fuel analysis approach.
 - b.) Generalized approach (e.g., emission factors).

For this example scenario, let's focus on a generalized approach using emission factors for stationary combustion sources.

Generalized Approach

Example Greenhouse Gas Emission Factors for Natural Gas Combustion:

- 116.87 lb/MMBtu for CO₂
- 0.011014 lb/MMBtu for CH₄
- 0.000022 lb/MMBtu for N₂O

(Source: Inventory of U.S. Greenhouse Gas Emissions and Sinks, April 2008. U.S. EPA.)

(Note: Emission factors can likely be obtained from a variety of sources so make sure you reference and/or justify them, as appropriate.)

Global Warming Potentials:

- Carbon dioxide (CO₂) = 1
- Methane (CH₄) = 21
- Nitrous oxide (N₂O) = 310

(Source: Table A-1, CFR Title 40, Part 98, Subpart A)

Miscellaneous Assumptions:

1. Natural Gas Compressor Engines Fuel Consumption = 8500 Btu/hp-hr @ Maximum Design Capacity
2. Reboilers Fuel Consumption = 256 MBtu/hr @ Maximum Design Capacity
3. Natural Gas Heat Value = 1020 Btu/scf

Calculations:

The GHG emissions calculations will be completed by calculating the CO₂ emissions and converting the CH₄ and N₂O to their CO₂e and summing the CO₂e for each GHG.

Emitting Unit #1: Natural Gas Compressor Engines

Fuel Consumption:

$$800\text{-hp} * 8500 \text{ Btu/hp-hr} * 1/1020 \text{ Btu/scf} * 1 \text{ Mscf}/1000 \text{ scf} = 6.67 \text{ Mscf/hr} = 160 \text{ Mscf/day} = 58,400 \text{ Mscf/yr} = \underline{58.4 \text{ MMscf/yr}}$$

Heat Produced:

$$58.4 \text{ MMscf/yr} * 1020 \text{ Btu/scf} * 1,000,000 \text{ scf}/1\text{MMscf} = 59,568,000,000 \text{ Btu/yr} = \underline{59,568 \text{ MMBtu/yr}}$$

Carbon Dioxide (CO₂):

116.87 lb/MMBtu * 59,568 MMBtu/yr * 1 ton/2000 lb = 3,480 tons/yr of CO₂

Methane (CH₄):

0.0011014 lb/MMBtu * 59,568 MMBtu/yr * 1 ton/2000 lb = 0.328 tons/yr CH₄

Nitrous Oxide (N₂O):

0.000022 lb/MMBtu 59,568 MMBtu/yr * 1 ton/2000 lb = 0.00066 tons/yr N₂O

Total GHG Emissions for Compressor Engines on a Mass Basis:

3,480 tons/yr of CO₂ + 0.328 tons/yr CH₄ + 0.00066 tons/yr N₂O = **3,480 tons/yr** of GHGs on a mass basis

Total Emissions of carbon dioxide equivalent (CO₂e):

Carbon Dioxide (CO₂e):

116.87 lb/MMBtu * 59,568 MMBtu/yr * 1 ton/2000 lb = 3,480 tons/yr of CO₂

Methane (CO₂e):

CH₄ in tons/yr * GWP for CH₄ = CO₂e for CH₄

0.328 tons/yr CH₄ * 21 = **6.88 tons/yr CO₂e**

Nitrous Oxide (CO₂e):

N₂O in tons/yr * GWP for N₂O = CO₂e for N₂O

0.00066 tons/yr N₂O * 310 = **0.02 tons/yr CO₂e**

Sum the Total CO₂e Emissions:

CO₂e emissions for the compressor engines = 3,480 tons/yr CO₂e + 6.88 tons/yr CH₄ (CO₂e) + 0.02 tons/yr N₂O (CO₂e) = **3,487 tons/yr CO₂e**

Applicability PSD Analysis Overview:

Question #1: Does this permit action result in a net increase of any criteria pollutant above PSD significant emission rates (SER)?

Yes, potential NO_x emissions are greater than the 40 tpy threshold so a PSD analysis for NO_x would be required.

Question #2: Does this permit action have GHG emissions above the PSD threshold on a mass basis?

Yes, the GHGs emissions on a mass basis are approximately 3,480 tpy.

Question #3: Does this permit action have CO₂e emissions above the PSD threshold?

No, the CO₂e emissions of 3,487 tpy are less than the 75,000 tpy CO₂e threshold.

If the answer to Questions #2 and #3 are both “Yes”, then GHGs must undergo a PSD review based on the following.

1. If the permit department decision occurs before January 2, 2011, GHGs are not required to be addressed in the PSD review.
2. If the permit department decision occurs between January 2, 2011 and July 1, 2010, GHGs must be included in the PSD review if any criteria pollutants are above significant levels.
3. If the permit department decision occurs on or after July 1, 2010, GHGs must be included in the PSD review along with any criteria pollutants above significant levels.

Title V Applicability Analysis/Overview:

Question #1: Is the facility an existing Title V facility?

Question #2: Are the potential emissions of GHGs greater than 100 tons per year?

Question #3: Are the potential emissions as CO₂e greater than 100,000 tons per year?

If the answer to Questions #1, #2, and #3 is “Yes”, a Title V permit action to address GHGs are described in the following scenarios.

- A department decision occurring before January 2, 2011, would not require GHGs to be addressed in the Title V permit.
- A department decision occurring after January 2, 2011, must address GHGs in the Title V permit.
- A department decision occurring after July 1, 2011, must address GHGs in the Title V permit.

If the answer to Questions #2 and #3 is “Yes”, a Title V permit action to address GHGs are shown as follows:

- A department decision occurring before January 2, 2011, would not require GHGs to be addressed in the Title V permit.
- A department decision occurring after January 2, 2011, would not require GHGs to be addressed in the Title V permit.
- A department decision occurring after July 1, 2011, would require GHGs to be addressed in the Title V permit.